Next Generation Air Monitoring

US EPA Region 4

Air Monitoring Workshop

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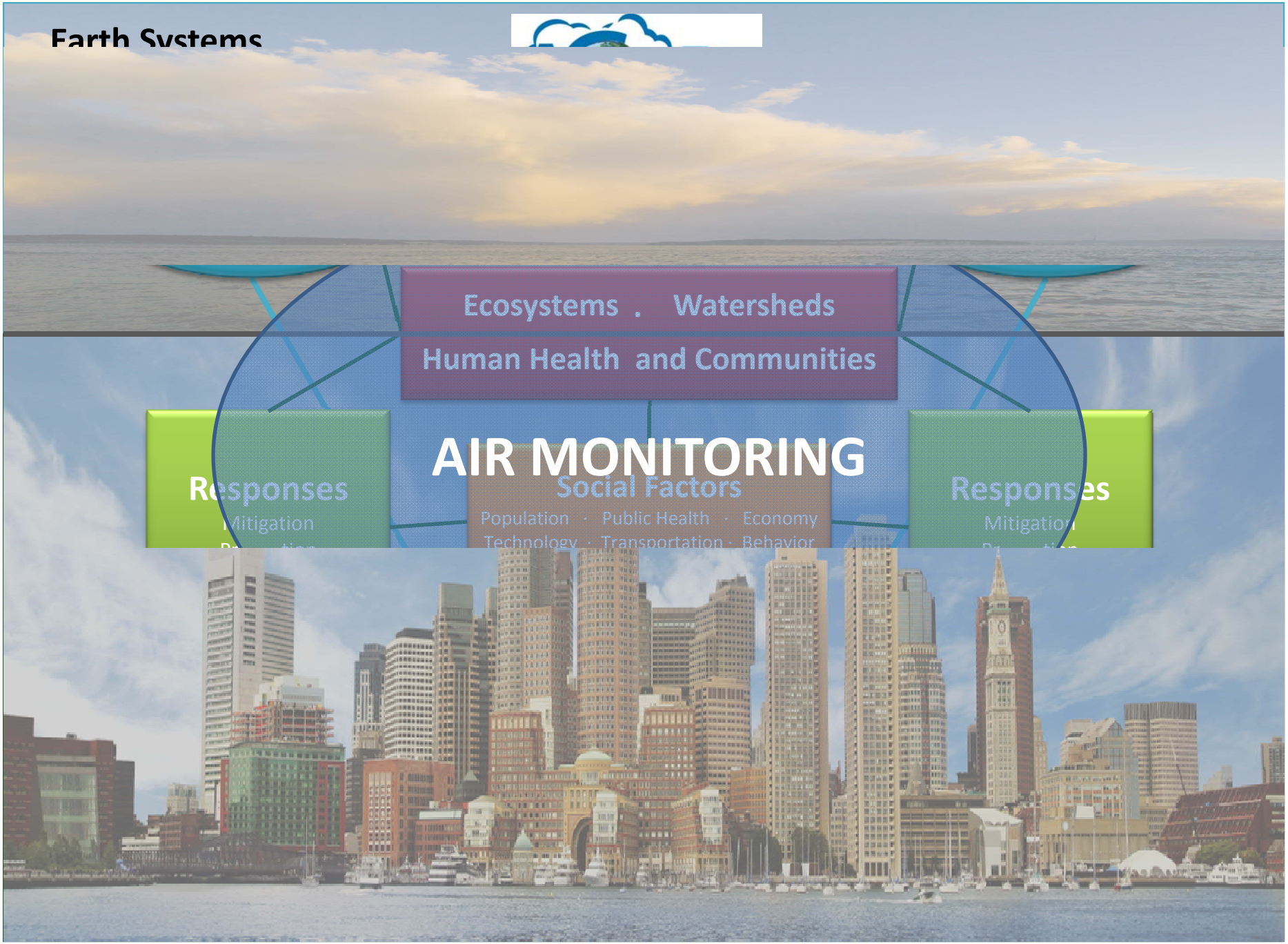
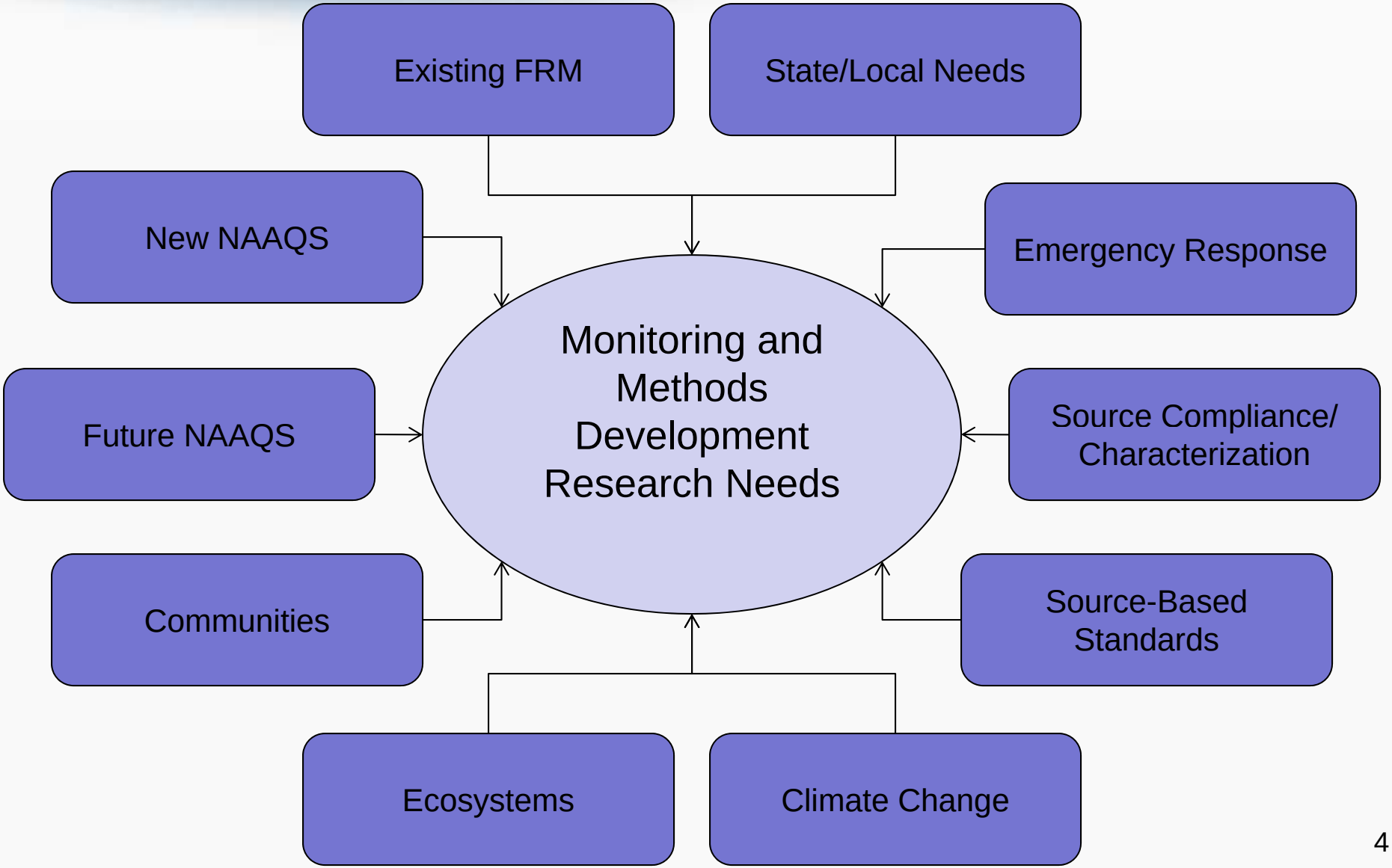
Overview

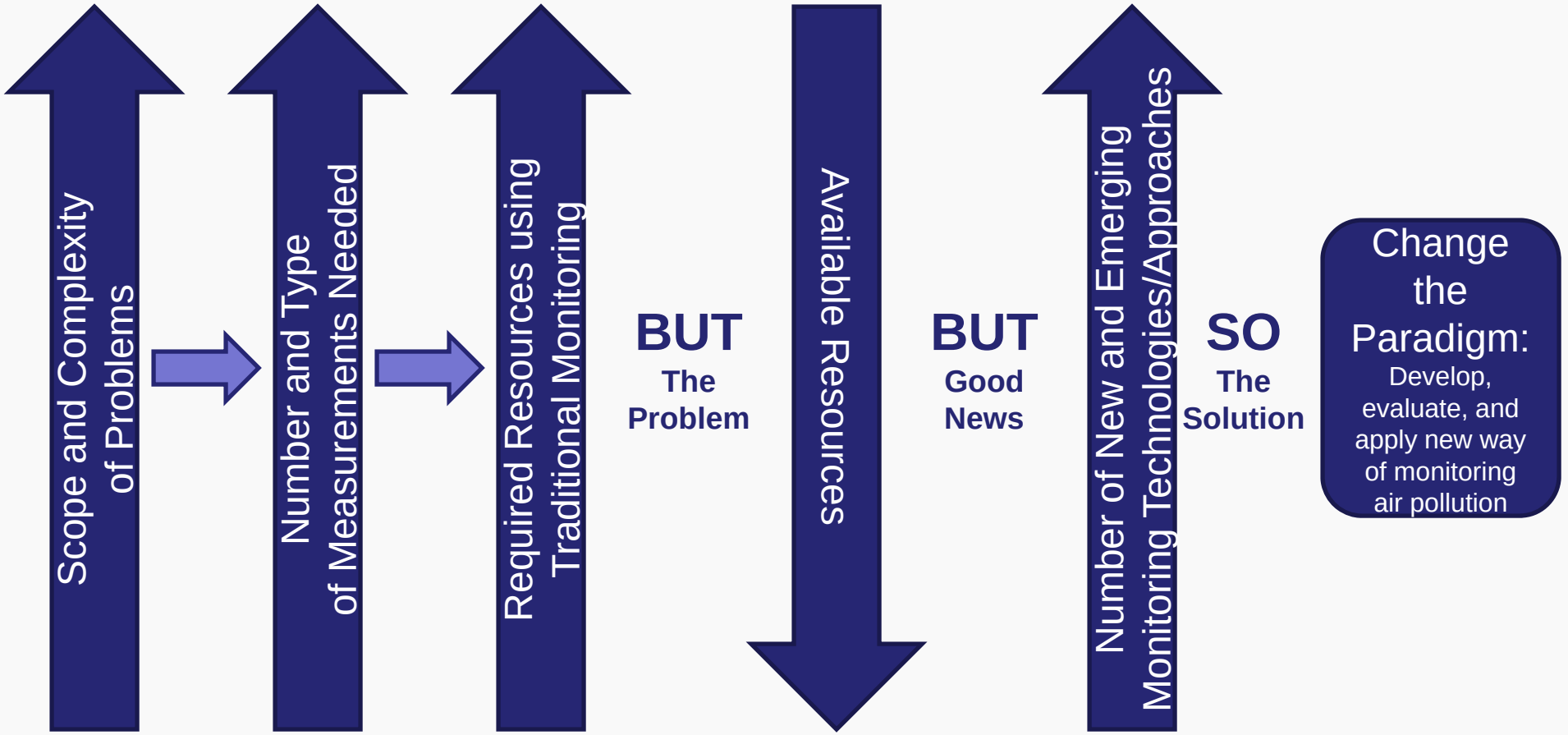
- Context and Drivers for Next Generation Air Monitoring
- EPA Next Generation Air Monitoring Activities
- The Future


Earth Systems
Ecosystems . Watersheds
Human Health and Communities
AIR MONITORING
Responses
Mitigation
Social Factors
Population · Public Health · Economy
Technology · Transportation · Behavior
Responses
Mitigation

Many Drivers for Air Monitoring and Methods Development Research



Changing the Paradigm for Air Pollution Monitoring



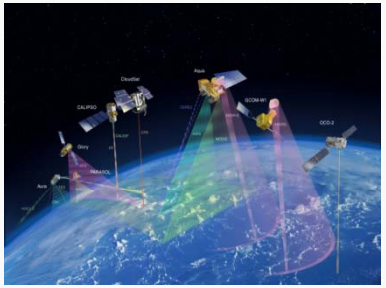
Changing the Paradigm for Air Pollution Monitoring

From Sensors to Satellites

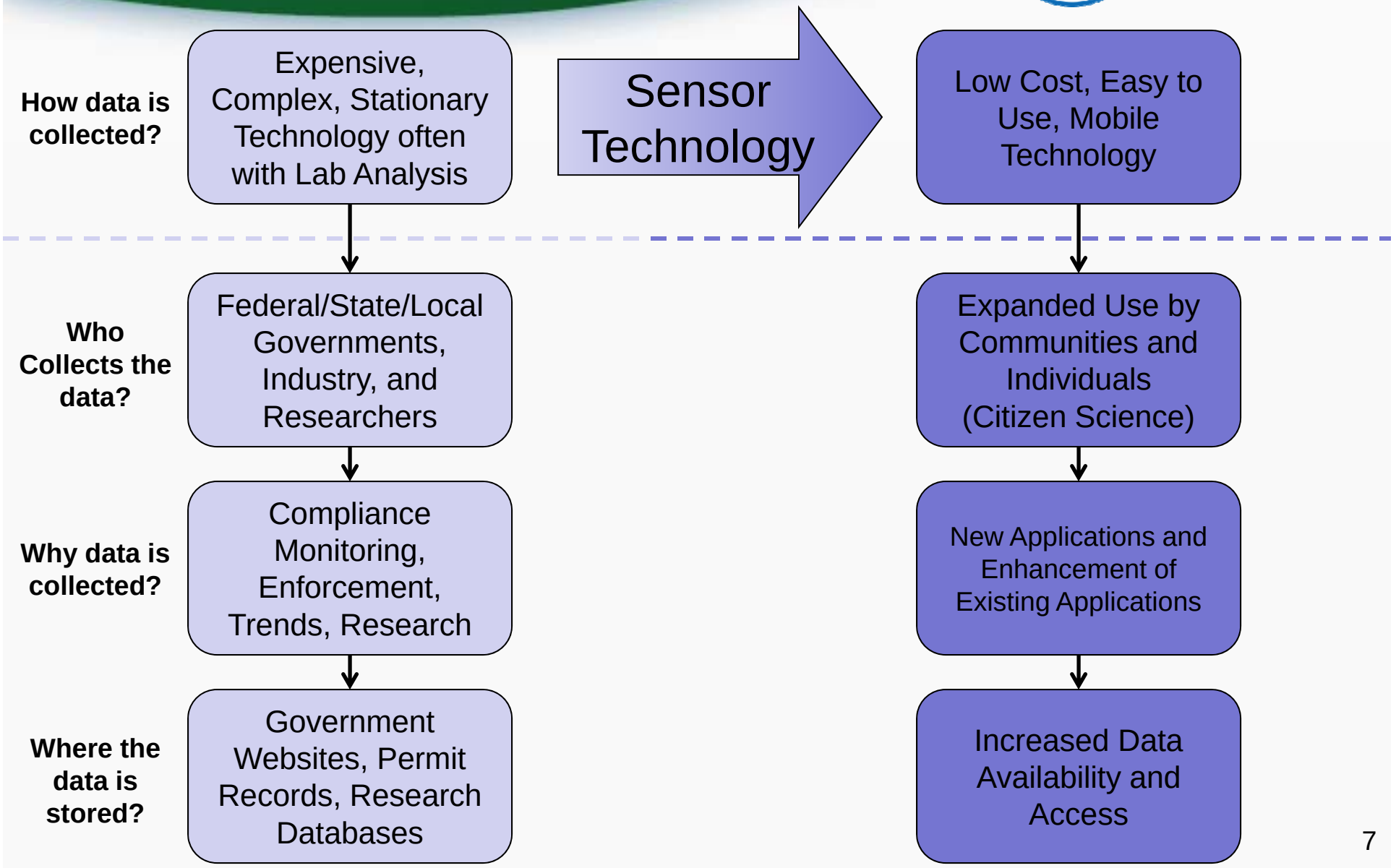
- Sensors
  - Present both Opportunities and Challenges
  - Evaluating a range of technologies


(communitysensing.org)

- Data Fusion
  - Integrating modeling data with monitoring data to fill spatial and temporal gaps.



Changing the Paradigm for Air Pollution Monitoring with Sensor Technology



Next Generation Air Monitoring (NGAM)

- Rapid progress in air monitoring technology
  - Development in public & private sectors, academia, DIYers
- Active citizen involvement changes perceptions, attitudes, behaviors, and level of engagement
- Decreasing costs
- Portability / miniaturization
- Increased spatial/temporal resolution
- Current dearth of monitoring; future may be overloaded

NGAM: A Challenge and an Opportunity for EPA

- Federal/State/Local governments need to prepare for data deluge
- Federal/State/Local governments will also have new sources of data to better manage air quality and protect public health
- EPA can remain on the sidelines and then constantly be in a reactionary and/or damage control mode

OR . . .

- EPA can get in game and engage with the early adopters and developers of these sensors and take a leadership role
- *If we're involved, we can help direct this technology to be used in a fashion that is appropriate and most useful to us as regulators and to communities and the public.*

Some Recent EPA NGAM Activities

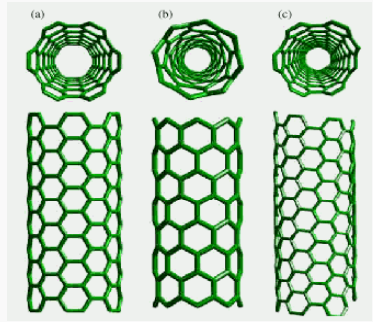
- Next Generation Air Monitoring (NGAM) Workshops/Webinar
- Open Source Challenges
- Sensors Open House
- Village Green Project
- Source Oriented Monitoring
- Roadmap for Next Generation Air Monitoring

Next Generation Air Monitoring (NGAM) Workshop Series

- Apps and Sensors for Air Pollution (ASAP) Workshop I /NGAM 1 (March 2012)
  - Convened wide variety of attendees
  - 20 quick presentations describing work with sensors already underway
  - Launched CitizenAir.Net – Discussion forum for air pollution sensor development and use
  - Catalyzed new partnerships, across academia, local government, non-profits and communities
- NGAM Webinar – September 2012
  - Summary of ORD Efforts
  - Regional Case Studies
- NGAM 2 – November 2012
  - Understanding Regional Needs and Exploring Solutions
- Air Sensors Workshop/ NGAM 3 – March 2013
  - Share information about recent efforts in the area of apps of sensors for air pollution
  - Define the acceptable data uncertainty objectives for different monitoring purposes
  - Explore and promote inexpensive approaches for quantifying accuracy of measurements, calibrating instruments
  - Discuss approaches to address data challenges such as managing a sensor network, data management, visualization for public use, communication, IT infrastructure, data analysis and data mining

Open Source Challenges

- Benzene
  - Multiple EPA programs and regional offices expressed a need for a real-time, field deployable, sensitive sensor for atmospheric benzene and 1,3 butadiene at low (ppb) concentrations
  - ORD worked with programs and regional offices to first understand the basic requirements for this sensor and to develop a challenge.
  - A challenge was posted in April 2012.
  - Solution pairs the demonstrated measurement sensitivity of carbon nanotubes with the compound selection properties of imprinted polymers



Carbon nanotubes

- My Air/My Health
  - Joint challenge between EPA and HHS.
  - A multidisciplinary call to enable near-real-time, location-specific monitoring and reporting of air pollutants and potentially related physiological parameters, using a personal/ portable integrated system to assess connections between the two (“sensor systems”).
  - Challenge posted in June 2012
  - Four Phase I finalists announced in November 2012
  - Phase II (Proof of Concept) underway

My Air
My Health

U.S. Department of Health and Human Services
U.S. Environmental Protection Agency

Sensor Evaluation Open House

www.epa.gov/airscience

AIR CLIMATE & ENERGY RESEARCH PROGRAM
BUILDING A SCIENTIFIC FOUNDATION FOR SOUND ENVIRONMENTAL DECISIONS

Sensor and Apps Evaluation Opportunity

WHAT: EPA offers technology developers the opportunity to send in your sensor for evaluation in a controlled laboratory setting.

WHEN: Nominate your device by June 30, 2012
Testing to occur July – September, 2012

HOW: Device developers should submit a statement of interest to EPA by June 30, 2012 providing basic information about their device. Due to capacity constraints, EPA will accept a limited number (~10) devices for evaluation over a range of pollutant concentrations and environmental conditions (e.g. humidity and potential interferences). Participants will be invited to visit the EPA lab in early July to discuss their instruments, the evaluation protocol, and receive a tour of the facility. Following the completion of the evaluation each participant will receive information on the performance of their device under known environmental conditions.

QUESTIONS or Point of Contact: Ron Williams, 919-541-2957, williams.ronald@epa.gov

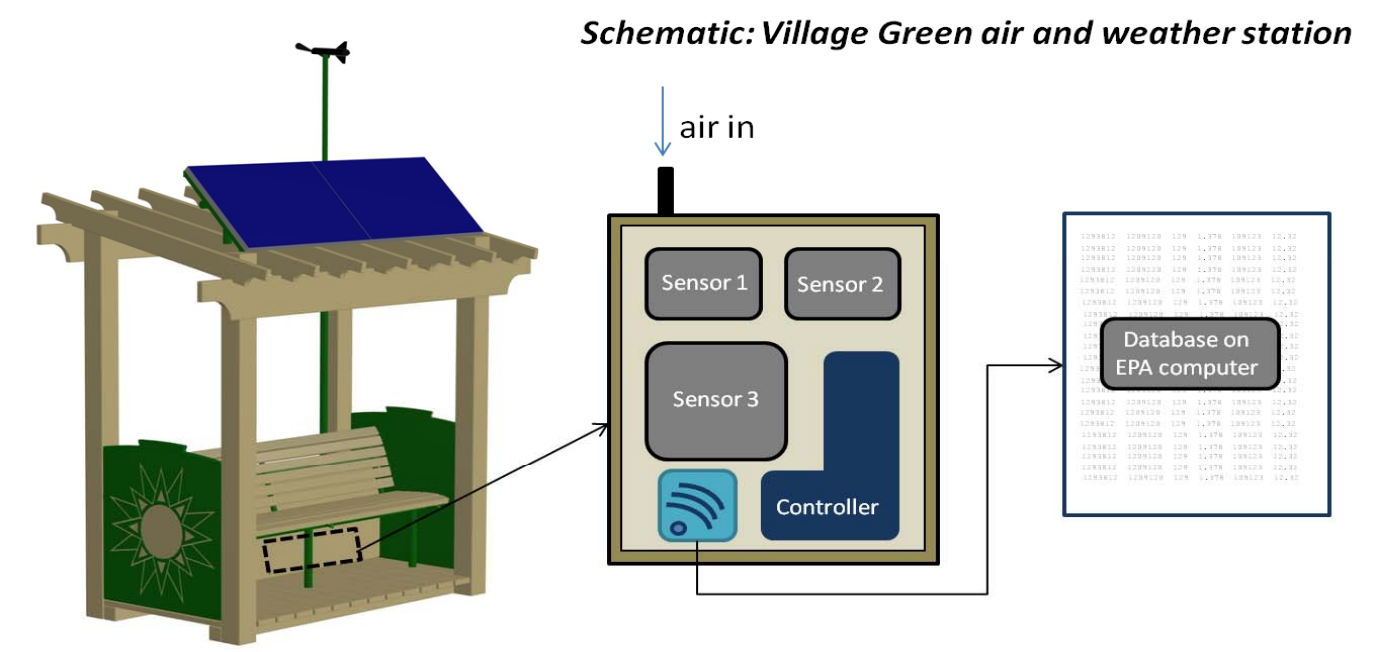
SELECTION CRITERIA: Devices receiving the highest consideration:

- have the technical feasibility to measure NO_2 and/or O_3 at environmentally relevant concentrations,
- have some preliminary data on expected performance characteristics,
- have not previously undergone standardized evaluations under known challenge test conditions by any party, and
- represent highly portable sensor and smart phone type applications featuring continuous measurement capabilities.

- Open call for potential collaboration
- O_3 and NO_2 focus
- Test bed evaluation
- Provide for collaborative interaction between EPA and sensor developers
- A total of 9 research groups nominated devices for evaluation
- Variety of DIY, smartphone, and modular devices
- Formal cooperative agreements established
- Not FRM/FEM Evaluations
- Results available soon.

The Village Green Project

- Self-powered air and meteorological sampler
- Lower cost, real-time instruments - proven capability at ambient levels (wind, black carbon, $PM_{2.5}$, ozone)
- Wireless data communication to publically-accessible website
- Designed for public environments



Source Oriented Monitoring: Fugitive and Area Sources

Agricultural operations, industrial fugitives, coal mining, waste water, oil and gas production, landfills, and more

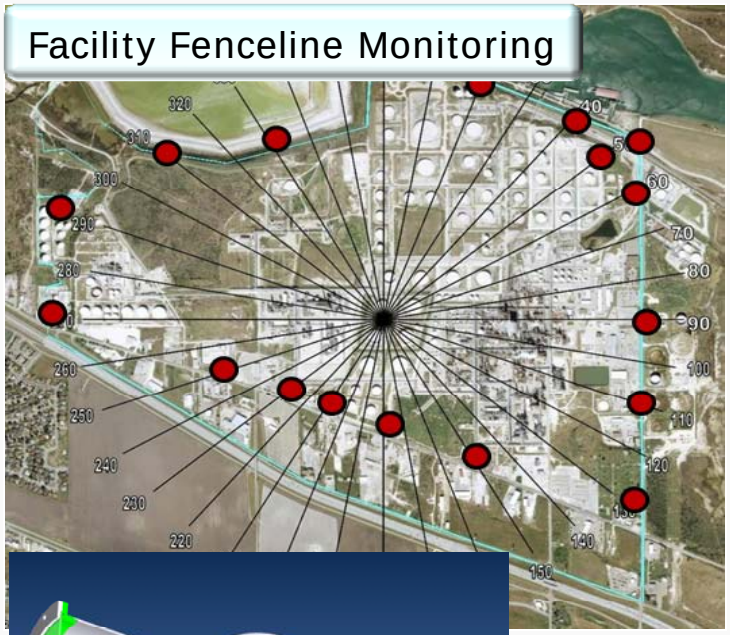
- spatially variable
- temporally variable
- large spatial extent

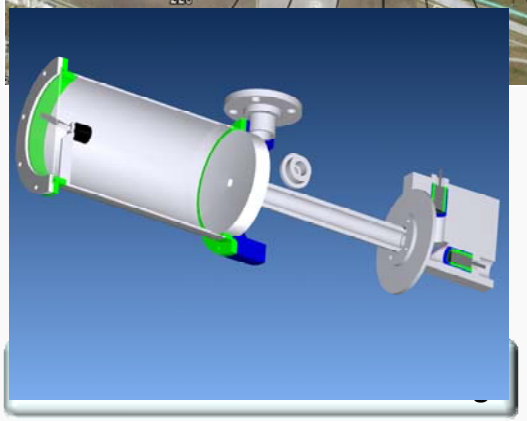
Source: Microsoft Bing Maps (© Microsoft Corporation Pictometry Bird's Eye © 2010 Pictometry International Corp.)

NGAM Provides New Opportunities for Source Oriented Monitoring

Mid-range Sensors and Remote Measurements

Facility Fenceline Monitoring

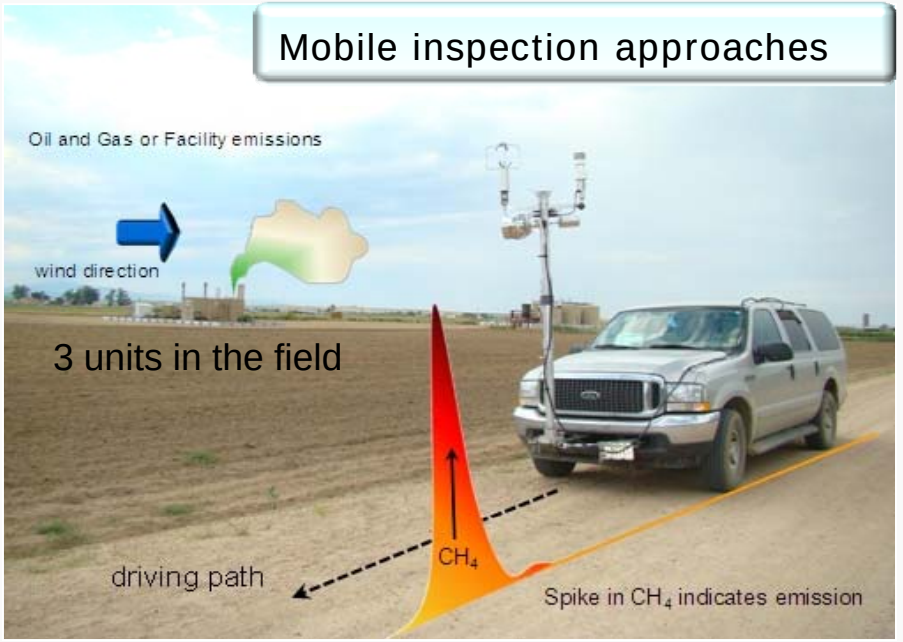




Advanced LDAR and fugitive strategies

- In-plant sensor networks
- IR camera protocols
- Passive samplers

Mobile inspection approaches



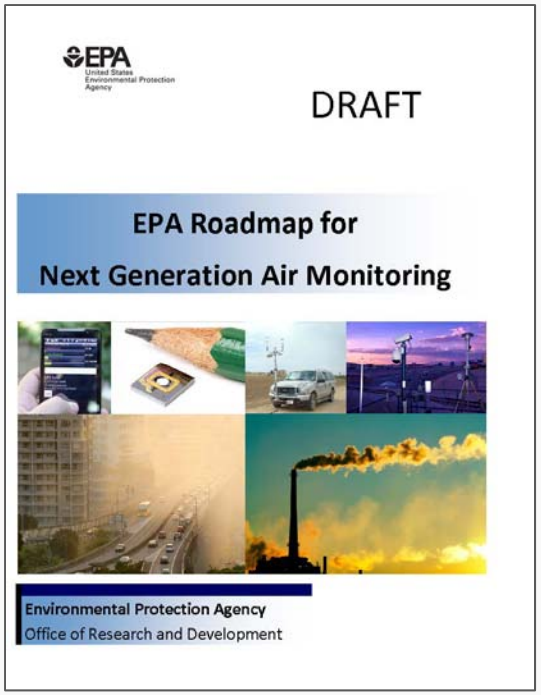
EPA Roadmap for Next Generation Air Monitoring

- Goals
  - Affordable near source, fenceline monitoring technologies and sensor network-based leak detection systems
  - Supplement air quality monitoring networks through development of low cost, reliable air quality sensor technology
  - Support environmental justice (EJ) communities and citizen science efforts to measure air pollution in local areas

- Cross Cutting Areas of Focus
  - Technology Development, Testing, and Integration
  - Technology Demonstration, Outreach and Communication
  - IT infrastructure and New Data Streams

- For Each Area of Focus
  - Major Findings/Conclusions
  - Recommendations/Gaps
  - Short and Long Term Priorities
  - Implementation Strategy

- Draft version available at Air Sensors 2013 Workshop website: https://sites.google.com/site/airsensors2013/final-materials



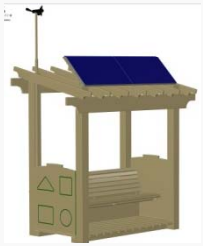
A Possible Future for Air Monitoring

Air monitoring in the future may exist on several tiers…

existing

emerging

Tier 1: Official regulatory or special purpose monitoring
Cost: $$$$$$$, Data = A+



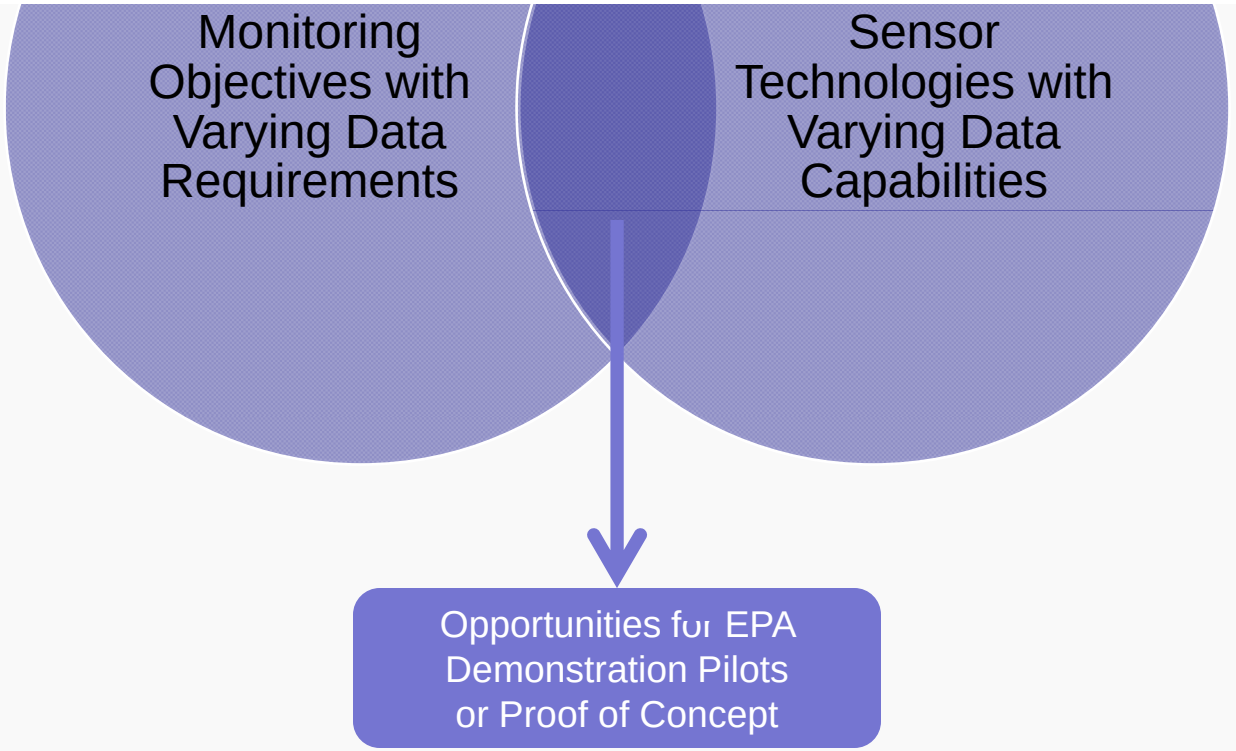
Tier 2: Monitoring for research and educational purposes
Cost: $$, Data = B+ (target)

CairClip

Air Quality Egg

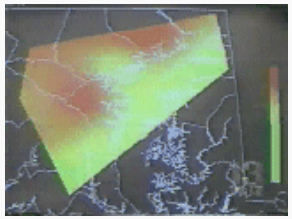
Tier 3: DIY, citizen science, education, and research
Cost: $, Data – TBD

Finding Opportunities for Advancing the Application of Sensor Technologies for Air Monitoring



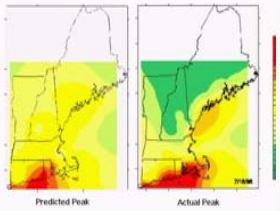
Case Study: AIRNow

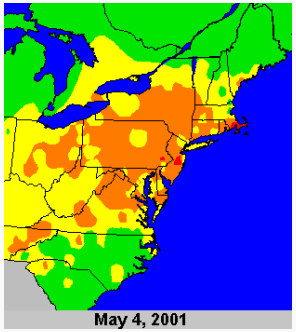
1995: Idea to report real-time air quality data



- Concerns over technical ability to deliver data in a timely fashion
- Concerns about data quality
- Concerns over misuse of the data

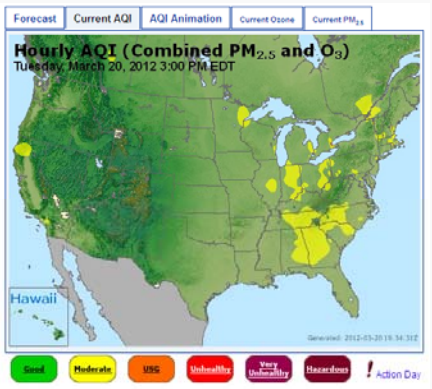
  Concerns over sustainability of the program

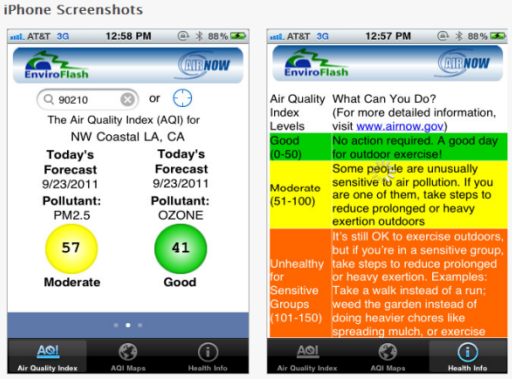


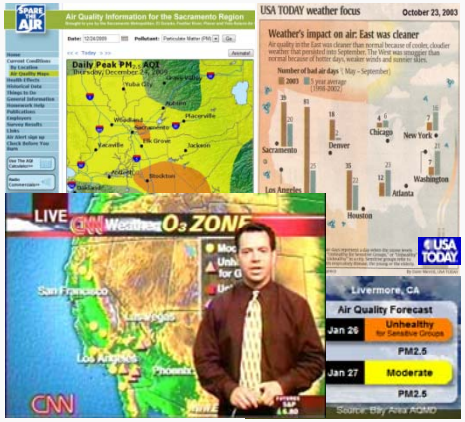


Today: EPA's AIRNow program

- Data delivered from more than 130 agencies, 24/7, 365 days/year including Canada
- AIRNow International
- Air quality now part of mainstream weather pages
- Data embraced by stakeholders and public







For More Information

- EPA Air and Climate Research Websites
  - http://www.epa.gov/airscience/
  - http://www.epa.gov/research/climatescience/
- NGAM 3 Workshop
  - https://sites.google.com/site/airsensors2013/
- Tim Watkins
  - watkins.tim@epa.gov
  - 919-541-5114